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Patentanmeldung Nr. Patent application No. Demande de brevet n°

02080514.9

Der Präsident des Europäischen Patentamts:
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
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Scanning two-dimensional array of light emitting units

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Scanning two-dimensional array of light emitting units

TECHNICAL FIELD

The present invention generally relates to the field of projecting images on screens and more particularly to a method and device for providing images on a screen.

DESCRIPTION OF RELATED ART

Within the area of displays, there is a constant search for improved displays, since many of the ones existing today are either bulky, costly or inefficient.

Some types of displays like LCDs (Liquid Crystal Display) have a technique with a continuous lamp source and shutters where light is always generated. This is not efficient. Even though the light is attenuated afterwards LCDs often need colour filters in order to provide colours, which lowers the efficiency of the device even more such that it needs more energy to work satisfactorily.

Another type of display only generates light when needed on a pixel basis. One example of this type of device is a CRT (Cathode Ray Tube). However, this device needs vacuum in order to work and therefore requires among other things a thick glass envelope.

Other types of displays are plasma displays. They are however very expensive today and have a low efficiency.

One type of light source having good properties for displays is a LED (Light Emitting Diode). The LED is in itself quite small, can be controlled to switch on and off in a fast manner and also provides good colours at a high efficiency. There is one drawback with LEDs though, and that is that they need a big housing round each LED, which has led to the use of LEDS so far being limited to large billboards and giant screens.

There have been some attempts to reduce the number of LEDs used. WO 01/29808 shows how an array of red, green and blue LEDs is scanned onto a screen using a rotating mirror. Here the array includes one column of green LEDs, one column of red LEDS and one column of blue LEDs in a first variation. Each column is then scanned through the aid of the mirror such that each combination of red, green and blue diodes provides one row of pixels. In a second variation of this array, there are provided two columns of each colour

LED slightly displaced from each other in the vertical direction, where the LEDs of the additional column of a colour provides the light for every other row of the screen. The first variation is bulky, because of the length of the columns. The second variation has halved the length, but it is still a quite bulky array. What is common to both these solutions is that the array of LEDs is one-dimensional. Each LED provides all the pixels for one row. This means that scanning of a row in the device is using one LED of one colour. The mirror used also has to be quite large, which adds to the cost of the device. The document WO-01/29808 also describes using two mirrors in order to scan three LEDS, one for each colour, over a screen in both a horizontal and a vertical direction. Here there is no array at all. Because of the large areas scanned in a direction, the image may be distorted. The mirrors also have to be rotated fast, which might be hard to accomplish.

There is thus a need for an array that can be made smaller, that needs only small displacements of light incident on a screen such that distortion of projected images is avoided and that enables the use of a lower rotational speed for displacing the light on a screen than in existing devices and methods.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide smaller displacements of light incident on a screen from a two-dimensional small array of light emitting units such that distortion of projected images is avoided and that enables the use of a lower rotational speed for displacing the light on a screen, for example by using more facets.

According to a first aspect of the present invention, this object is achieved by a method of providing images on a screen comprising the steps of:

- emitting light from a first set of light emitting units provided in a two-dimensional array having at least two lines of light emitting units, each line including at least two light emitting units,
- projecting the light from said first set of light emitting units on the screen, and
- displacing the light projected on the screen from each light emitting unit, such that each light emitting unit provides a tile of the screen including at least two pixels in a line aligned in one direction on the screen.

According to a second aspect of the present invention, this object is also achieved by an image projection device comprising:

- at least one first set of light emitting units provided in an array including at least two lines of light emitting units having at least two light emitting units, and

– a light displacing unit arranged to displace the light from each light emitting unit before projection on a screen, such that each light emitting unit provides a tile comprising a line including at least two pixels aligned in one direction on the screen.

Claims 3 and 13 are directed towards providing tiles extending also in a vertical direction.

Claims 5 and 12 and 16 are directed towards providing a light transmission medium for displacing light from the array of light emitting units.

Claim 14 is directed towards providing equal displacement from line to line.

Claim 17 is directed towards providing reflective light transmission mediums.

Claims 6 and 20 are directed towards reducing stitching effects.

Claim 18 is directed towards enabling further reduction of an array of light emitting units, in case more than one colour is used.

The present invention has the advantage of providing a small sized image display device that at the same time only needs a limited scan range. This limits distortion of projected images and that enables the use of a lower rotational speed for displacing the light on a screen.. The invention furthermore provides a beneficial form factor and enables the use of other means of displacing the light than mechanical.

The general idea behind the invention is thus to provide a limited size two-dimensional array of light emitting units for projection on a screen, where the light from each light emitting unit is displaced in at least one direction in order to provide a tile of pixels on the screen.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be explained in more detail in relation to the enclosed drawings, where

Fig. 1 shows a schematic drawing of a device according to the invention for projecting images on a screen,

Fig. 2 shows a first set of LEDs provided in an array for projection of light on [redacted],

Fig. 3 schematically shows the light from the LEDs in the array of fig. 1 is projected onto the screen,

Fig. 4 schematically shows a light displacing unit in the form of a light transmissive wheel,

Fig. 5 shows a first light displacing characteristic of a segment of the wheel in fig. 4,

Fig. 6 shows a transflective unit together with first, second and third sets of LEDs for providing an even smaller device,

Fig. 7 shows a flow chart of a method of providing images on a screen according to the invention,

Fig. 8 schematically shows two transmissive units as an alternative to the wheels of fig. 4,

Fig. 9 shows an alternative reflective wheel, and

Fig. 10 shows two reflective units as an alternative to the reflective wheel,

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention relates to the provision of images on a screen and more particularly to providing pixels for a screen using an array of light emitting units that has to be kept small. Fig. 1 generally shows a device for projecting an image on a screen according to the invention. The device 16 is preferably provided in a display and then preferably in a television set. The device can also be provided in a projector, arranged to project images on a large screen. The device 10 includes a first set of light emitting units 12, which light emitting units are preferably LEDs (Light Emitting Diodes) provided in a two-dimensional array or matrix. The LEDs are provided in rows and columns such that each LED in one column is aligned with one LED in each other column and each LED in a row is aligned with one other LED in each other row. The array 12 is connected to control electronics 18 arranged to provide each LED with control signals for turning them on and off in order to provide pixel information to be displayed. The array 12 therefore generates light, which falls onto a light displacing unit 14. The light displacing unit 14 is connected to a control unit 20 arranged to provide change of position of the light displacing unit 14 for providing displacing of the light emitted from all LEDs in the array. The light from all the LEDs in the array 12, after passing the light displacing unit 14 is projected on a projector unit 16 provided in the form of a projection lens, which projects the light on a screen 17, which screen 17 can be the projector screen provided for a projector by a user or be made of a display material, receiving the light from the LEDs on a back side and displaying information on the front side, when provided in a television set or perhaps in a large computer display.

Fig. 2 shows a few LEDs provided in an array 12. Here there are three types of LEDs. A first type 22 providing the colour red, a second type 24 providing the colour green and a third type 26 providing the colour blue. The distance between two LEDs of the first type 22 is indicated with a first box 28 having dashed lines, the distance between two LEDs 24 of the second type 24 is indicated by a second box 30 having solid lines and the distance between two LEDs of the third type 26 is indicated by a third box 32 having dotted lines. The third box 32 is not shown in its entirety in the figure. As is apparent from the drawing each LED is covered by a housing for directing the light. These housings are quite large. If the array in fig. 1 and 2 would have one LED for each colour and each such three colour combination assigned to just one pixel on the screen, the display device would become very large and bulky and not possible to include in such devices as television sets. Note that the device would become very bulky even if three different colours are not used, i.e. if the device were only to provide pixels in black and white or in gray scale. There is thus a need to limit the number of LEDs used. The invention solves this problem by letting one LED in an array of LEDs provide a tile of pixels in both the horizontal and vertical direction.

Fig. 3 shows how the light from a number of LEDs is projected on the screen 16. The array 12 is here simplified in that it only includes 9 LEDs numbered from 1 to 9 provided in three rows and three columns, where LEDs 1 –3 are provided in a first row, LEDs 4 – 6 are provided in a second row and LEDs 7 – 9 are provided in a third row. The LEDs here furthermore only represent one colour for better understanding of the invention. It should be realised that there can be two additional LEDs for each shown in fig. 3. The LEDs are originally projected in a first position on the screen 17, which is indicated by bold numbers 1 – 9 in rows 1, 3 and 5 on the screen. Then the light from each LED is displaced horizontally in three steps, which is indicated in the right part of fig. 3 showing the screen with the numbers 1, 2, 3, 4, 5, 6, 7, 8, and being repeated three times in rows 1, 3 and 5, such that these rows are completed. This means that the light from a LED is displaced three times after the original projection. The information that a LED is displaying is however varied so that each of the displayed numbers represents a pixel on the screen. This variation of information of a LED is achieved by suitable switching on and off of the LED in question by using the control electronics shown in fig. 1. After these rows 1, 3 and 5 have been scanned, the light from all the LEDs is displaced vertically in one step starting from a position furthest to the right, i.e. with the bold numbers 1 – 9 in rows 2, 4 and 6, and the light from the LEDs is scanned in the same way as described above in order to provide the pixels of rows 2, 4 and 6. Each LED therefore provides light for a tile of which one 34 for LED number 4 is

indicated in fig. 3. Here a LED thus provides the light for 8 pixels in four columns and two rows. The array therefore provides information for all pixels of the screen. The above described scheme is automatically repeated for all colours. It should furthermore be realised that fig. 3 is a mere example for understanding the invention. It is often desirable to provide more pixels from one LED both horizontally and vertically such that the array can be made smaller.

Fig. 4 shows one first preferred variation of a light displacing unit 14 according to the invention. Here there is shown a wheel 36 with octagonal shape and having eight segments 38. Light from the LEDs is arranged to be incident on the uppermost segment of the wheel. The segments 38 are provided in the form of a light transmissive material and can be made out of individual prisms. The wheel is made to rotate and during rotation the light from the set of LEDs incident on a surface of a segment 38 is displaced upon exiting the segment. Two variables are available for making a certain displacement, thickness of material and angle. With these two design freedoms one can make a wheel to have the desired scan behaviour, e.g. like a CRT. The vertical direction is decided by the width W of a segment 38. Fig. 5 shows the principle behind this width variation. Light incident by an angle α, changes direction through the medium, because of the different material constants. Because the material has different widths in the horizontal direction, the exit point will differ depending on different entry points. It is here worth noting that when angle α is 0 degrees, the displacement is also zero. The light incident upon a surface is displaced with a varying horizontal distance so that all pixels in a line are provided. All segments have the same type of width variation so that displacement in the horizontal direction is the same for all segments. The surface against which light from the LEDs is incident is also angled against the direction of the light in the vertical direction. Each segment has a different angle to the incident light. This means that the angle of incidence, will be different for each segment. Each segment 38 therefore displaces the rays of light with a different shift. In this way the vertical displacement of the light is provided in order to provide scanning of different rows for the LEDs.

By using the combination of wheel and first array, a small enough sized display can be obtained that can be included in for instance a television set. By using a transmissive wheel, the dimensions of the total device can be kept low, which enables the provision of an even smaller device.

Fig. 6 shows another variation of the invention. Here there is provided three sets of LEDs, 40, 42, 44, one for each colour and each providing all the pixels for the screen.

These three arrays are provided on three sides of a transflective device or colour recombination cube 46 having dichroic reflection properties, i.e. is reflective for light of different colours. One diagonal of the cube provides reflection such that red light from a first array 40 incident on a first side of the cube is reflected inside the cube, another diagonal of the cube provides reflection of blue light from a third array 44 incident on a third side of the cube. Light from the second array 42 incident upon a second side is passed transparently through the cube 46. In this way light from the first and third arrays 40, 44 is reflected inside the cube such that it coincides with the light from the second array 42. Therefore all the light leaves the cube from a fourth side. This light is then provided to the light displacing unit for projection on the screen. In this way each array can be smaller or more LEDs can be used and thus a smaller sized image projection device is possible to obtain. By this arrangement one array can be made three times smaller than the first described array.

An example of an array for providing a VGA (Video Graphics Array) display having 480x600 pixels can be provided by an array having 48 LEDs in the vertical direction and 60 in the horizontal direction. The array is then scanned in an analogue fashion in the horizontal direction, where the scan has to be 1/10 of a whole row. Displacements are also performed in 10 steps vertically. It is possible to limit the size of the device even further by providing an array of 12 LEDs in the vertical direction and 15 in the horizontal direction. The scan of the array in the horizontal direction is then 1/12 of a whole row and vertical scanning then have to be made in 40 steps. When the number of LEDs are diminished, the scan amplitude has to be raised in order to provide good performance of the device.

The optimal number of LEDs will be determined by a number of factors, including among other things the price of a single LED, the desired image brightness, the allowed scanning range, and the size of the optics.

Fig. 7 shows a flow chart of the method according to the invention, which thus can be used to summarize how the invention works. Light from a two-dimensional array of LEDs is emitted, step 52. The emitted light from each LED is displaced in both the horizontal and vertical direction such that each LED provides a tile of pixels in both the horizontal and vertical direction, step 54, whereupon the light is projected onto a screen, step 56.

The invention furthermore reduces stitching effects. By providing a slight overlap between the tiles of two neighbouring LEDs, the stitching effects are reduced. The light intensity of a LED close to a neighbouring tile is provided in the form of a sine wave shaped attenuation of the original video content by video processing. The light from the LED for the pixel in the neighbouring tile is also provided in the form of a sine wave shaped

attenuation of the original video content also by video processing. The light of the tile is made to overlap such that the original video content is fully restored. Small misalignment of the tiles will now be less visible and n this way stitching effects are reduced.

The invention can be varied in many ways, of which a few will be described in relation to fig. 8 - 10. Fig. 8 shows a variation of the wheel from fig. 5. Instead of having one wheel, it is possible to provide two perpendicular bars of transmissive material 48 and 50 rotating around a horizontal and a vertical axis providing vertical and horizontal displacement of the light according to the principles outlined above. However, it is not necessary to use transmissive material in the wheel and bars either, but it is equally as well possible to use reflective material. Fig. 9 shows a top view of a wheel having octagonal shape provided with mirrors instead of transmissive material. Each segment here provides different angles of incidence in both vertical and horizontal direction. By rotation of a segment one row is scanned. The different segments are angled differently in the vertical direction against the light from the LEDs, thus providing different rows as well. Fig. 10 shows another alternative with mirrors, where two rotating mirrors 62 and 64 are used for providing vertical and horizontal scanning. In case of a wheel, said wheel can have more or fewer sides than eight. An octagon provides eight rows, a pentagon five rows etc.

The number of LEDs used can furthermore be varied in many ways, thus fewer or more tiles than what has been described above can be used according to the invention. The invention is furthermore not limited to LEDs, but can be used in any case where the number of light emitting units needs to be limited.

The invention has the following advantages. The use of LEDs makes the device more efficient than other types of devices. A limited size array furthermore provides all of the pixels of a screen through the displacements used. Because a two-dimensional array is used, a better form factor of a projector engine is obtained compared to a large one-dimensional array solution. Because each LED provides a tile of limited size in horizontal and vertical direction, it might be possible to use other means for providing displacement than by using mechanical rotation if the number of light emitting units are large enough. The cube furthermore allows the separation of LEDs of different colours in three different arrays, which makes it possible to reduce the size of a device even further.

CLAIMS:

1. Method of providing images on a screen, comprising the steps of:
- emitting light from a first set of light emitting units provided in a two-dimensional array having at least two lines of light emitting units, each line including at least two light emitting units,
- projecting the light from said first set of light emitting units on the screen, and
- displacing the light projected on the screen from each light emitting unit, such that each light emitting unit provides a tile of the screen including at least two pixels in a line aligned in one direction on the screen.

2. Method according to claim 1, wherein each unit in a line is aligned with another unit in all other lines, where the light emitting units of one line provides light for different pixels than the units of other lines and at least two of the light emitting units in each line are arranged to provide light for separate pixels on said screen.

3. Method according to claim 1, wherein the line is a vertical line and the light from each light emitting unit is displaced in a vertical direction so that the pixels of a tile are aligned vertically and the step of displacing further includes displacing the light projected on the screen from each light emitting unit in a horizontal direction, such that each tile also comprises horizontally aligned pixels.

4. Method according to claim 1, wherein the first set of light emitting units ~~provides~~ light for all pixels of the screen.

5. Method according to claim 1, wherein the step of displacing includes the step of transmitting the light of each light-emitting unit through a transmission medium.

6. Method according to claim 1, wherein the step of displacing is performed in such a way that the tile of one light emitting unit in a set slightly overlaps the tile of at least one neighbouring light emitting unit in said set.

7. Image projection device comprising:

- at least one first set of light emitting units provided in an array including at least two lines of light emitting units having at least two light emitting units each, and
- a light displacing unit arranged to displace the light from each light emitting unit before projection on a screen, such that each light emitting unit provides a tile comprising a line including at least two pixels aligned in one direction on the screen.

8. Image projecting device according to claim 7, wherein each light emitting unit of a line is aligned with another unit in all other lines, where the light emitting units of one line provides light for different pixels than the units of other lines and at least two of the light emitting units in each line are arranged to provide light for separate pixels on said screen.

9. Image projection device according to claim 7, further including a screen onto which light from the first set of light emitting units is projected.

10. Image projection unit according to claim 7, wherein the first set of light emitting units provides light for all pixels of the screen.

11. Image projection device according to claim 7, wherein the light displacing unit comprises a first medium rotatable around a first axis for providing tiles having at least two pixels aligned in a first direction on the screen.

12. Image projection device according to claim 11, wherein the first medium is transmissive and the light displacing unit includes a number of segments of the first medium, rotatable round said axis, and each segment has a varying width for displacing the light from a set of light emitting units in the first direction.

13. Image projection device according to claim 11, wherein the light displacing unit comprises a number of segments of the first medium, each segment is provided with a first side facing the light emitting units and providing a different angle of incidence for the light from a set of light emitting units, such that the light from said set of light emitting units is displaced in a second direction by each segment for providing the tiles with pixels also aligned in the second direction.

14. Image projection device according to claim 12, wherein all the segments have the same width variation.

15. Image projection device according to claim 12, wherein the segments are provided as a number of prisms provided round a wheel and providing a polygonal shape to the light displacing unit.

16. Image projection device according to claim 11, wherein the light displacing unit further comprises a second medium rotatable round a second axis perpendicular to the first axis for displacing the light projected on the screen from each light emitting unit in a second direction and both the first and second mediums are transmissive.

17. Image projection device according to claim 11, wherein the light displacing unit further comprises a second medium rotatable round a second axis perpendicular to the first axis for displacing the light projected on the screen from each light emitting unit in a second direction and both the first and second mediums are reflective.

18. Image projection device according to claim 7, further including a second and a third set of light emission units and a transflective unit, wherein the transflective unit is arranged to reflect the light of the first set of light emitting units, reflect the light of the second set of light emitting units and transmit the light of the third set of light emitting units.

19. Image projection device according to claim 18, wherein the transflective unit is placed such that the light from the different sets of light emitting units passes the transflective unit before reaching the light displacing unit.

20. Image projection device according to claim 7, wherein the light displacing unit is arranged such that a tile slightly overlaps neighbouring tiles.

21. Image projection device according to claim 7, in which it is a display.

22. Image projection device according to claim 7, in which it is a projector.

23. Television set incorporating a display according to claim 22.

ABSTRACT:

The invention relates to a method of providing images on a screen and an image projection device. The image projection device (10) comprises at least one first set (12) of light emitting units provided in an array including at least two lines of light emitting units having at least two light emitting units each, and a light displacing unit (36) arranged to displace the light from each light emitting unit before projection on a screen (16), such that each light emitting unit provides a tile comprising a line including at least two pixels aligned in one direction on the screen. The light emitting units are preferably LEDs, and in this way an efficient display or projector that can be accommodated in a reasonably small space is provided.

Fig. 1

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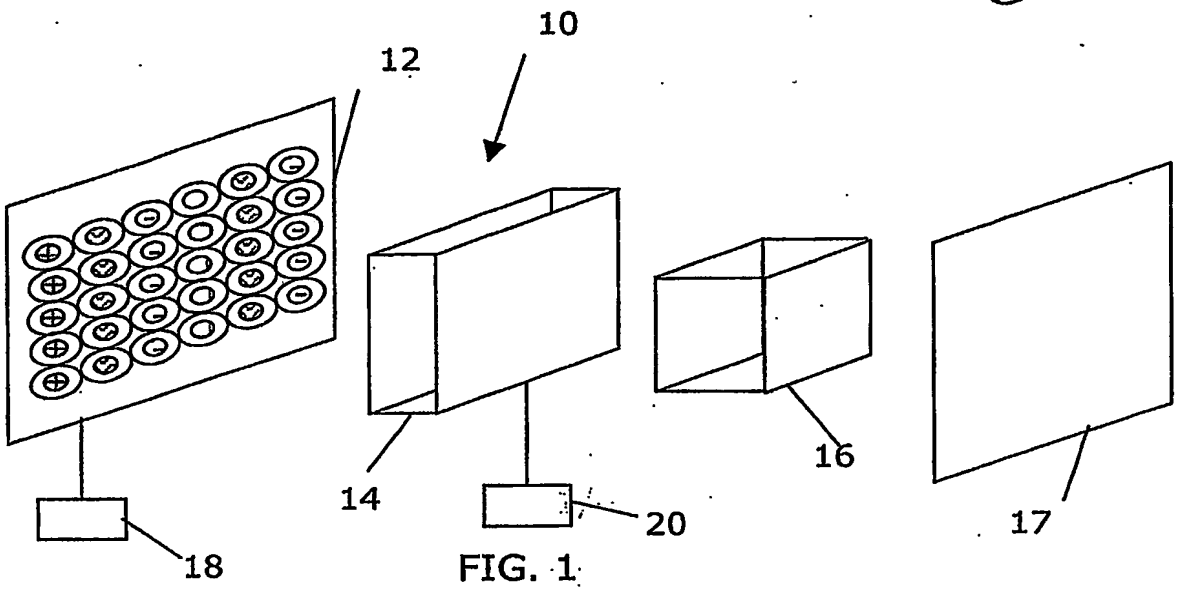

FIG. 1

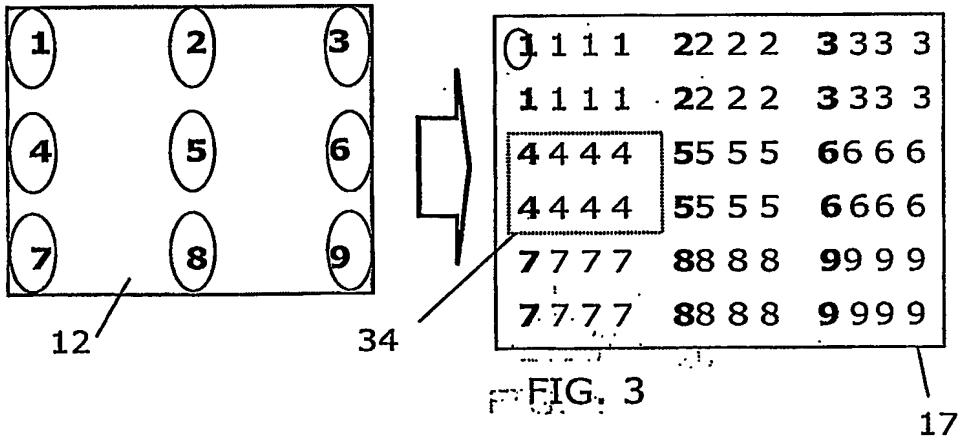

FIG. 3

FIG. 3

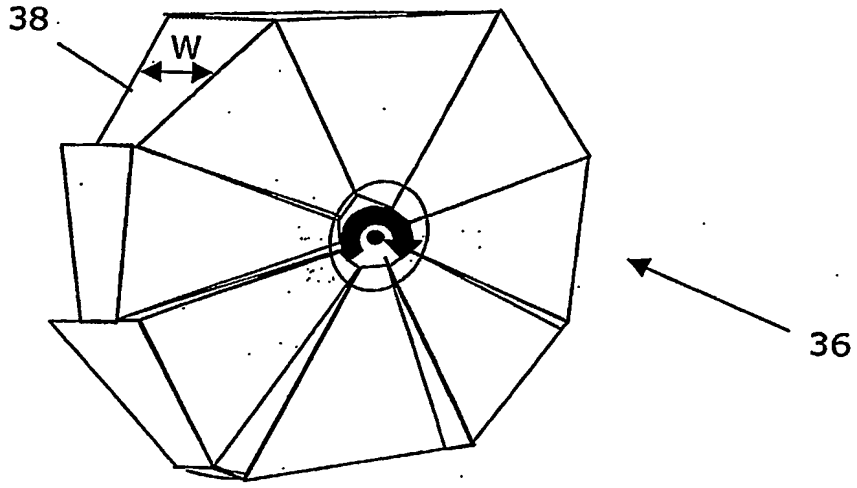

FIG. 4

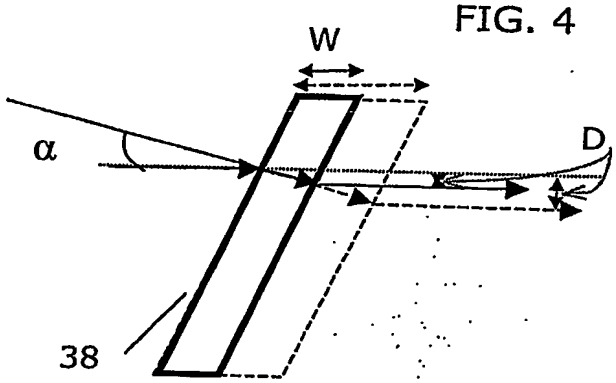

FIG. 5

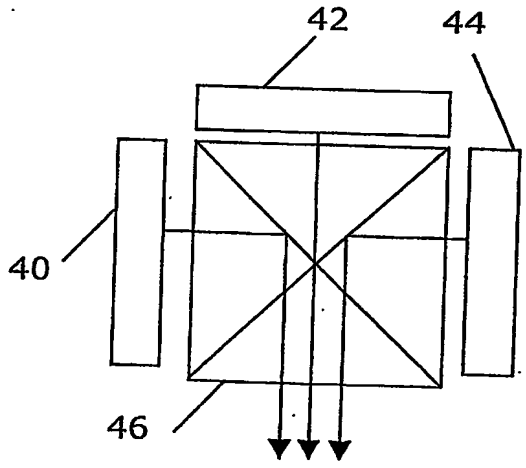

FIG. 6

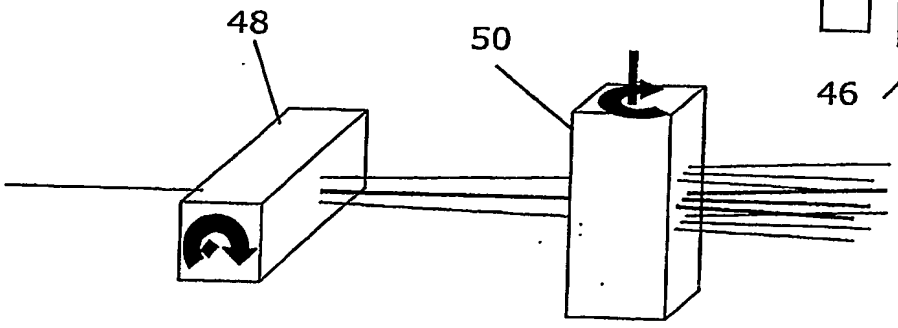

FIG. 8

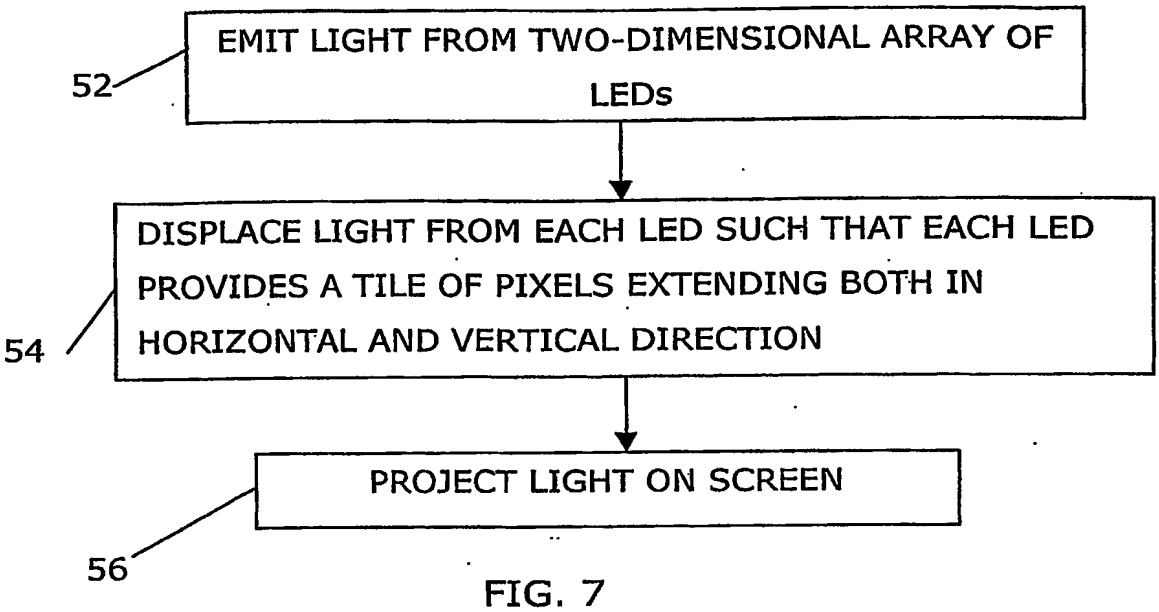

FIG. 7

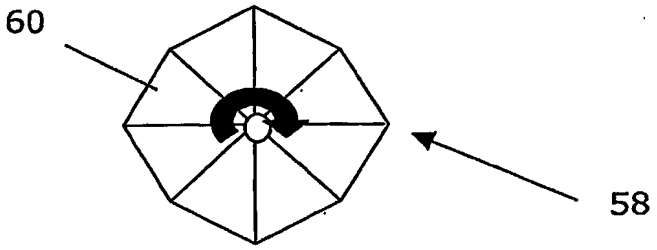

FIG. 9

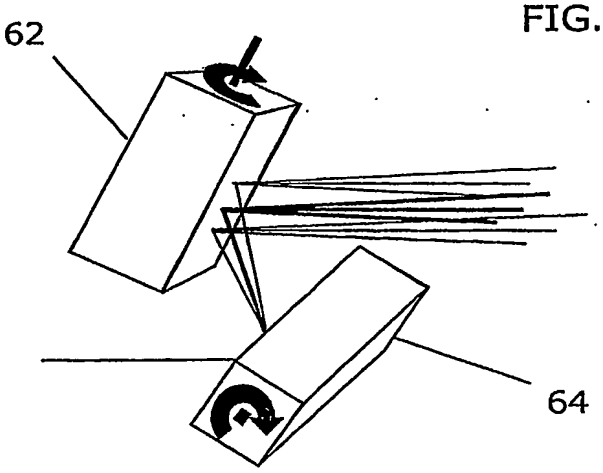

FIG. 10

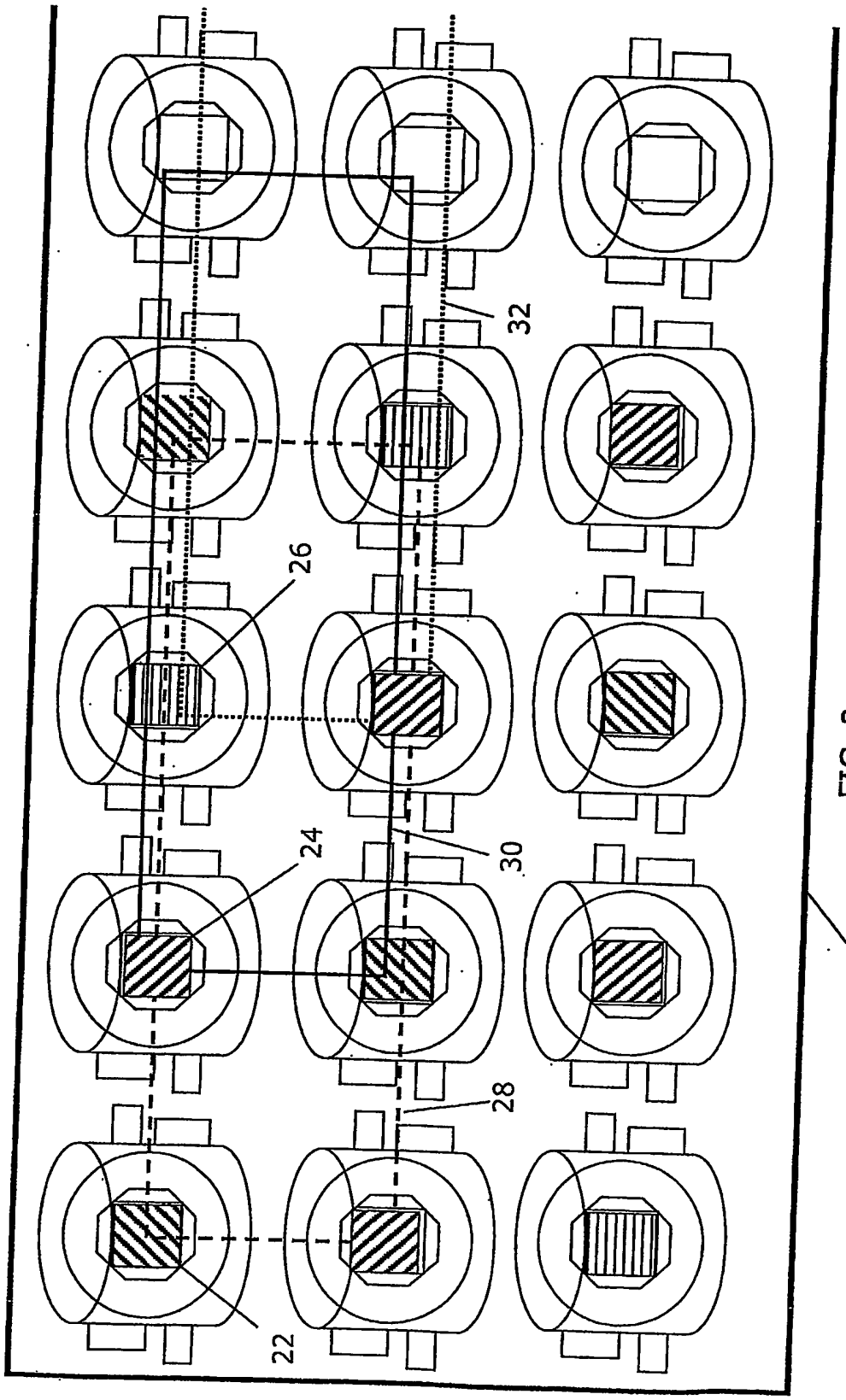

FIG. 2